

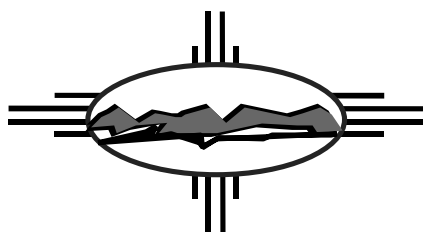
STANDARD OPERATING PROCEDURE

Title: **Soil Water Samples**

Identifier:
ER-SOP-6.05

Revision:
1

Effective Date:
03/08/99



ER PROJECT

APPROVALS FOR USE

Author's Name (Print):

Jennifer Pope

Author's Signature:

Date:

03/08/99

Quality Program Project Leader's Name (Print)

Larry Maassen

Quality Program Project Leader's Signature

Date:

03/08/99

LOS ALAMOS NATIONAL LABORATORY

Soil Water Samples

Table of Contents

1.0 PURPOSE	3
2.0 TRAINING	3
3.0 DEFINITIONS.....	3
4.0 BACKGROUND AND PRECAUTIONS	4
5.0 EQUIPMENT	4
6.0 PROCEDURE.....	5
7.0 REFERENCES.....	11
8.0 RECORDS	11
9.0 ATTACHMENTS.....	11

Soil Water Samples

NOTE: Environmental Restoration (ER) Project personnel may produce paper copies of this procedure printed from the controlled document electronic file. However, it is their responsibility to ensure that they are trained on and utilizing the current version of this procedure. The procedure author may be contacted if text is unclear.

1.0 PURPOSE

This Standard Operating Procedure (SOP) defines the equipment and proper method for sampling water in soil.

2.0 TRAINING

The **Field Team Leader** (FTL) is responsible for ensuring that field team members who sample water in soil for the ER Project are trained in the operation of soil water samplers (lysimeters). In addition all field team members who use this procedure shall be familiar with the objectives of soil water testing and must document that they have read and understand this procedure in accordance with QP-2.2.

3.0 DEFINITIONS

- 3.1 Drilling string — The string of pipe, which extends from the bit to the driving mechanism, that serves to carry the mud down the borehole and to rotate the bit.
- 3.2 Site-Specific Health and Safety Plan (SSHASP)—A health and safety plan that is specific to a site or ER-related field activity that has been approved by an ER health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.
- 3.3 Split-spoon sampler — A hollow, tubular sampling device below the drill stem that is driven by a weight to retrieve soil samples.
- 3.4 Unsaturated hydraulic conductivity — A coefficient that describes the rate at which a fluid can potentially move through a permeable, unsaturated medium (EPA, 1986).

- 3.5 Vadose zone — A zone between the ground surface and the water table that contains water below atmospheric pressure and air or gasses at atmospheric pressure. Also known as the zone of aeration or unsaturated zone.

4.0 BACKGROUND AND PRECAUTIONS

Note: This SOP is to be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

The sampling devices can be damaged as a result of intrusion by people, wildlife, livestock, or mechanical equipment. Fencing around the site may be necessary. Do not cover the surface area directly above the soil water samplers in a way that interferes with the normal percolation of soil moisture down to the depth of the sampler.

5.0 EQUIPMENT

A checklist of suggested equipment and supplies needed to implement this procedure is provided in Attachment A. A description of a soil water sampler, its advantages, and its limitations is given below.

- 5.1 Soil water samplers, or lysimeters, are used to sample water in the vadose zone. The lysimeter applies pressure to the vadose zone, which mobilizes pore water that partially fills the soil particle interstices. Once the water is mobilized, it will move toward and will collect in the sampling vessel of the lysimeter. If present, contamination generally is mobilized along with the water and can be detected as constituents in the pore water.

5.1.1 Three common types of lysimeters are available: vacuum, pressure-vacuum, and high-pressure-vacuum. Selection of the appropriate lysimeter is based on the target sampling depth. The vacuum lysimeter is designed to sample in a vadose zone that extends from 0 to 6 ft below ground level; the pressure-vacuum lysimeter is designed to sample up to 50 ft below the surface; and the high-pressure-vacuum lysimeter is designed to sample at greater depths. Soil water samples may be obtained from shallow depths with a hand pump and from greater depths with pressurization provided by an inert gas such as nitrogen. Lysimeters can be installed singly or in clusters of one or more at varying depths. The site-specific work plan will define the types of lysimeters and the sampling locations and depths.

5.1.2 Lysimeters may be installed in a variety of subsurface environments and soil types. Lysimeters are most efficient in unconsolidated granular soils that range in particle size from coarse sand to silt. Lysimeters may not perform efficiently in clay soils. Pore pressures in

clay may be great enough to significantly reduce transport of soil water.

- 5.1.3 A variety of drilling methods may be used to achieve the desired depth for lysimeter installation. However, drilling methods that employ fluids should not be used. Borehole integrity must be maintained, and the drilling method should be chosen accordingly.

6.0 PROCEDURE

Note: Deviations from SOPs are made in accordance with QP-4.2.

6.1 Preoperation Activities

- 6.1.1 Assemble the equipment and supplies listed in Attachment A. Ensure the proper operation of all sampling equipment.
- 6.1.2 Coordinate all sampling efforts with the Sample Management Office (SMO).
- 6.1.3 Lysimeters are generally packaged in protective plastic by the manufacturer; therefore, a distilled water rinse is sufficient before use. (These procedures may vary according to the manufacturer's specifications.) The use of harsh chemicals may damage the equipment.

6.2 Assembly of Soil Water Sampler

- 6.2.1 After the hole has been drilled, immerse the porous ceramic cups of the soil water samplers in distilled water until saturated (approximately 1 hr). Use distilled water to thoroughly flush the sampler cup before installation. The porous cup must be saturated when installed.
- 6.2.2 Determine the length of access tubes (0.25-in. Teflon tubing). Two lengths of access tubing are required.
 - 6.2.2.1 Connect discharge and internal collection tubing.
 - 6.2.2.2 The pressure vacuum tube should protrude to approximately 0.5 in. above the ceramic plug.
- 6.2.3 Allow the tubing to stick out above the polyvinyl chloride (PVC) cap, and identify each tube by function. Wrap all threaded connections with Teflon tape as a sealant.

6.3 Installation of Soil Moisture (Water) Sampler

Once the lysimeter has been assembled, install the sampler into the drilled or bored hole. The porous ceramic cup must be kept in tight contact with the soil during drilling so that soil moisture can readily move from the soil to the

lysimeter. Select either of the following installation methods—based on the drilling method used.

6.3.1 Hollow-stem auger drilling (ER-SOP-4.01)

- 6.3.1.1 Install the lysimeter through the hollow stem while the auger is in the ground.
- 6.3.1.2 Terminate auguring, and use a split spoon (3-in. outside diameter [OD]) to knock the plug out of the bottom of the auger to collect the final foot of material approximately 1 ft above the desired depth of the instrument installation.
- 6.3.1.3 After completion of the boring, add about a 1-in. layer of slurry silica flour (200-mesh silica flour), using distilled water, to the bottom of the borehole.
- 6.3.1.4 Install the lysimeter so that it rests directly on the silica flour.
- 6.3.1.5 Add a 2- to 4-in. layer of slurry to the hole; be sure to envelope the ceramic tip of the instrument.
- 6.3.1.6 Add about 1 ft of moist, 50-mesh quartz sand.
- 6.3.1.7 Retract the auger 3 to 4 ft and gently tamp the sand with a 1-in.-diameter rod or tremie pipe inserted through the hollow stem. Use the tamping rod to keep the instrument seated as the auger string is retracted.
- 6.3.1.8 Add 50-mesh sand and tamp with the rod in intervals of 1 to 2 ft, until the sand covers the silica flour and the auger is completely withdrawn.

6.3.2 Air rotary drilling (ER-SOP-4.01)

- 6.3.2.1 Terminate drilling at the desired depth of instrument installation.
- 6.3.2.2 Withdraw all drill pipe and bit from the borehole and add about a 1-in. layer of slurry silica flour (200-mesh silica flour), using distilled water, to the bottom of the borehole.
- 6.3.2.3 Install the lysimeter so that it rests directly on the silica flour.
- 6.3.2.4 Add a 2- to 4-in. layer of slurry to the hole; be sure to envelope the ceramic tip of the instrument.
- 6.3.2.5 Add about 1 ft of moist, 50-mesh quartz sand.
- 6.3.2.6 Gently tamp the sand with a 1-in.-diameter rod or tremie pipe.

- 6.3.2.7 Add 50-mesh sand and tamp with the rod in intervals of 1 to 2 ft, until the sand covers the silica.

6.4 Final Installation

- 6.4.1 After the installation of the sampler is inspected, place a bentonite seal above the sand. This seal can be installed by either of the two methods of layering bentonite and native-soil fill. The two bentonite-seal schemes are shown in Attachment C.
- 6.4.2 After installing the bentonite seal, backfill the borehole until the backfill material is level with the native ground surface. If the sampler is being installed at a site known to be uncontaminated, native soil previously removed from the hole may be used as backfill. If, by using native soil, there is any possibility of introducing contaminated soil or tailings into the borehole, use clean, well-graded sand as backfill.
- 6.4.3 As soon as practical after installation, have the field technician use the pressure-vacuum pump to extract the slurry water that was introduced with the silica flour and silica sand (Attachment D). Continue purging until the same quantity of water that was used to prepare the slurry has been removed (Attachment E). Collect a soil moisture sample after the purging has been completed, as shown in Attachment F.
- 6.4.4 Sink a steel protective casing into the bentonite soil plug; surround the soil water sampler vacuum tubes.
 - 6.4.4.1 A casing is a mild steel pipe with a 6-in. diameter. The casing should extend approximately 2 ft into the plug and rise above the land surface about 1 ft. The top of the pipe should be filled with a hinged cap.
- 6.4.5 Protect the soil water sampler from possible damage by vehicular traffic or grazing livestock. Surround the protective casing with barrier posts to protect the location if appropriate.

6.5 Collecting Soil Water Samples

A vacuum applied within the soil water sampler causes moisture to move from the soil through the porous ceramic cup into the sample bottles. Because the rate at which a sample is collected is a function of the unsaturated hydraulic conductivity of the soil and the amount of vacuum that is created, the time required to collect a sample may vary. Generally, a vacuum of 50 to 80 centibars is sufficient to collect a sample in a few hours. However, under conditions of low conductivity or low moisture content in the soil, several days or weeks may be required to collect a sample. Because it

is usually impossible to collect enough sample for a complete analysis, the order in which the constituents are analyzed must be prioritized, as follows:

1. volatile organic compounds;
2. the following specific chemical elements (in order):
 - a. uranium (U)
 - b. molybdenum (Mo)
 - c. arsenic (As)
 - d. barium (Ba)
 - e. cadmium (Cd)
 - f. chromium (Cr), and
 - g. lead (Pb); and then
3. all other elements and compounds.

Note: The project leader may establish a different set of priorities for analysis.

Decontamination precautions are outlined in ER-SOP-1.08.

- 6.5.1 To collect a sample, close the pinch clamp on the discharge access tube and connect the vacuum port of the pressure-vacuum pump to the pressure-vacuum access tube. Vacuum is applied until approximately 60 centibars is created with the sampler, as read out on the gauge connected to the pump (Attachment D).
- 6.5.2 Securely close the pinch clamp on the pressure-vacuum access tube to seal the sampler under vacuum. Allow the sampler to sit for a period of time under vacuum.
- 6.5.3 To recover a soil water sample, attach the pressure-vacuum access tube to the pressure port on the pump. Place the discharge access tube in a small, clean collection bottle and open both pinch clamps. Develop enough pressure within the sampler to force the collected water out of the sampler and into the collection bottle (as shown in Attachment F).

Note: Whenever a sample is collected, a custody record must be initiated on the Sample Collection Log (Attachment B in ER-SOP-1.04) and the Chain-of-Custody/Request for Analysis Form (Attachment C in ER-SOP-1.04) and a Sample Label (Attachment A in ER-SOP-1.04) must be affixed to the sample container.

6.6 Sample Filtering/Preservation

6.6.1 Filtering

Before field measurements are taken, samples may need to be filtered. If more than 500 ml is available, a large filtering system may be used; otherwise, a syringe/filter system must be used. Procedures specific to collecting soil water samples are described below:

6.6.1.1 Large Filtering System

- a. Disassemble the filter apparatus and discard the old filter. Thoroughly rinse all surfaces that come in contact with the sample with distilled water.
- b. Make sure you are wearing clean gloves. Install a new filter; be sure to touch it only along its perimeter. Do not allow dirt or dust to blow onto the cleaned apparatus or filter. Reassemble the apparatus.
- c. Before you take any samples, run a few milliliters of sample water through the filter.
- d. Fill the sample bottles through the filter. Do not allow dirt or dust to blow into bottles or bottle caps.

6.6.1.2 Syringe/Filter System

- a. Fill the syringe with sample by drawing sample into syringe with the plunger.
- b. Connect a new syringe filter to the base of the syringe and force the sample through the filter into a clean sample bottle by depressing the syringe plunger.
- c. Repeat these steps until all samples have been filtered.
- d. Discard the used syringe and filter.

6.6.2 Preservation

6.6.2.1 If sample volume is less than 250 ml, acidify the sample. Add nitric acid (HNO_3) in sufficient volume to lower the pH of the sample to approximately 2.0. The pH of some soil water samples may be less than 2.0 without being acidified. If sample volume is more than 250 ml, put the next 150 ml into a bottle unacidified. Consult ER-SOP-1.02 for further instructions.

6.6.2.2 Note the amount and type of preservative on the data forms. Check the pH of the sample with pH paper to ensure that sufficient acid has been added. Once the appropriate

amount of acid has been added, cap the sample bottles and seal with tape.

6.7 Obtaining Field Measurements

- 6.7.1 Record all field measurements and comments on the Soil Water Sampling Field Data form (Attachment B). Fill out the form as described in the included instructions. Note any additional comments on the Daily Activity Log form (Attachment E in ER-SOP-1.04).
- 6.7.2 After the samples have been collected, measure and record pH, specific conductance, redox potential, temperature, alkalinity, and dissolved oxygen according to the instructions provided in ER-SOP-6.02. The field measurements will be recorded directly onto the Soil Water Sampling Field Data form (Attachment B).
- 6.7.3 Because some sample loss will occur during testing, take measurements only if you collect a sample that is larger than 500 ml. Do not perform alkalinity tests unless the pH of a sample is greater than 4.5. Guard samples against cross-contamination.
- 6.7.4 After completing the field measurements, record the number of sample containers collected in the middle section of the Soil Water Sampling Field Data form. Describe sample collection by volume (1 liter, 500 ml, 250 ml, or other specified volume) and by preservation method (nonacidified or acidified) and record the amount of acid (in milliliters) added for sample preservation to each acidified container.

6.8 Postoperation Activities

- 6.8.1 Ensure that all equipment is accounted for, decontaminated, and ready for shipment.
- 6.8.2 Restore the site to presampling conditions.
- 6.8.3 Make sure all soil water sampling locations are properly staked and the location ID is readily visible on the location stake.
- 6.8.4 Prepare samples for shipment and transport to the SMO.

7.0 REFERENCES

The following documents have been cited within this procedure.

QP-2.2, Personnel Orientation and Training

QP-4.2, Standard Operating Procedure Development

QP-4.3, Records Management

ER-SOP-1.02, Sample Containers and Preservation

ER-SOP-1.04, Sample Control and Field Documentation

ER-SOP-1.08, Field Decontamination of Drilling and Sampling Equipment

ER-SOP-4.01, Drilling Methods and Drill Site Management

ER-SOP-6.02, Field Analytical Measurements of Groundwater Samples

EPA "RCRA Ground Water Monitoring Technical Enforcement Guidance Document," (OSWER, Washington, D.C., 1986).

8.0 RECORDS

The **FTL** is responsible for submitting the following records (processed in accordance with QP-4.3) to the Records Processing Facility.

- 8.1 The completed Soil Water Sampling Field Data form (Attachment B).
- 8.2 Include all field notes and other pertinent data on the Daily Activity Log forms (Attachment E in ER-SOP-1.04).
- 8.3 A Sample Collection Log (Attachment B in ER-SOP-1.04).
- 8.4 Sample Labels (Attachment A in ER-SOP-1.04).
- 8.5 A Chain-of-Custody/Request for Analysis Form (Attachment C in ER-SOP-1.04).

9.0 ATTACHMENTS

The document user may employ documentation formats different from those attached to/named in this procedure—as long as the substituted formats in use provide, as a minimum, the information required in the official forms developed by the procedure.

Attachment A: Equipment and Supplies Checklist for Collecting Soil Water Samples (1 page)

Attachment B: Soil Water Sampling Field Data (form and completion instructions) (3 pages)

Attachment C: Soil Water Sampler Installation Showing Bentonite Seal (1 page)

Attachment D: Soil Water Sampler Installation Showing Pressure-Vacuum
Assembly (1 page)

Attachment E: Purging of Slurry Water with Soil Sampler (1 page)

Attachment F: Collection of Soil Water Samples (1 page)

Attachment G: Soil Water Sampler Installation (1 page)

Equipment and Supplies Checklist for Collecting Soil Water Samples

- _____ Complete lysimeter assembly—PVC Schedule 40 or Schedule 80
- _____ Porous ceramic cup(s)
- _____ Ceramic plug(s)
- _____ Body tube—PVC
- _____ 1/4-in.-diameter Teflon tubing
- _____ Teflon tape
- _____ Vacuum pump
- _____ Pinch clamps
- _____ 4-in. auger
- _____ 3/16-in.-ID × 1/8-in. wall neoprene tubing
- _____ Tamping rod
- _____ Distilled water
- _____ Bentonite pellets
- _____ pH paper
- _____ Sample containers and preservatives
- _____ pH meter
- _____ Alkalinity test kit
- _____ Thermometer
- _____ Filter assembly
- _____ 0.45-micron filters
- _____ Nitric acid (HNO₃)
- _____ Soil Water Sampling Field Data Forms
- _____ Daily Activity Log forms
- _____ Chain-of-Custody/Request for Analysis Forms
- _____ Sample Collection Log forms
- _____ Variance logs
- _____ Custody seals
- _____ Unique sample stickers
- _____ Sample labels
- _____ Any additional supplies listed in associated procedures, as needed.

ER-SOP-6.05

Los Alamos
Environmental Restoration Project

Soil Water Sampling Field Data

Date/Time: _____

Sheet _____ of _____

Technical Area (TA) _____ Operable Unit _____

Site Work Plan _____

Field Team Member Identification _____

(Print name and title, then sign)

Affix
First Sample
Sticker Here

Affix
Last Sample
Sticker Here

FINAL FIELD VALUES

pH (S.U.) _____	Volume of Sample Collected _____
Ec (µohms/cm) _____	Vacuum Applied _____
Eh (mvolts) _____	Location Description _____
Temperature (°C) _____	_____
Alkalinity (mg/l CaCO ₃) _____	_____
Dissolved Oxygen (mg/l) _____	_____

	<u>CONTAINER SIZE</u>	<u>NONACIDIFIED</u>	<u>ACIDIFIED</u>	<u>VOL ACID (ml)</u>
Number of Containers Collected:	One Liter	_____	_____	_____
	500 ml	_____	_____	_____
	250 ml	_____	_____	_____
Specify Others:	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____

COMMENTS: _____

☐ Check here if continued on the back of this sheet.

ER-SOP-6.05

Los Alamos
Environmental Restoration Project

Soil Water Sampling Field Data Form Completion Instructions

Use an indelible dark-ink pen. Make an entry in each blank. For entry blanks for which no data are obtained (except in Comments section), enter “UNK” for unknown, “N/A” for not applicable, or “ND” for not done, as appropriate. To change an entry, draw a single line through it, add the correct information above it, and date and initial the change. For all forms, complete the following information:

Header Information:

1. Date/Time—The date and time when the measurement was made, in the following formats: DD-MMM-YY (e.g., 01-JAN-91) and the 24-hr clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.).
2. Sheet Number—Number all the sheets that are used for this activity, by day or by some practical unit.
3. Technical Area (TA)—Two-digit number which indicates the TA in which the activity is being performed.
4. Operable Unit—Four-digit number indicating the Operable Unit in which the sampling is being done or sample is being studied.
5. Site Work Plan—Title of plan.
6. Field Team Member Identification—Print your name and position title, then sign.

Sample Identification:

- If the Daily Activity Log form addresses only one sample, attach a sticker from the batch of stickers that match the sticker number on the sample to the box on the form that reads “Affix First Sample Sticker Here,” and draw a line through the box labeled “Affix Last Sample Sticker Here.”
- If the Daily Activity Log form addresses a sequential number of samples, put the first matching sample sticker in the box marked “First” and put the last matching sample sticker in the box marked “Last.”
- If the sample identifiers used are not sequential, be sure to affix the lowest sample sticker number in the “First” box, record the remaining sample identifiers on the form and Daily Activity Log form, and draw a line through the “Last” box.

Final Field Values (Sampling conditions):

Record all other conditions pertinent to the sample collection in this section on the Daily Activity Log form (Attachment E in ER-SOP-1.04).

1. pH (S.U.)—The pH of the water sample, in standard units, at the time of collection.
2. Ec ($\mu\text{ohms/cm}$)—The specific conductance of the water sample, in micro-ohms per centimeter, at the time of collection.
3. Eh (mvolts)—The redox potential of the water sample, recorded in millivolts, at the time of collection.
4. Temp. ($^{\circ}\text{C}$)—The temperature of the water sample, recorded in degrees Celsius, at the time of collection.
5. Alkalinity (mg/l CaCO_3)—The alkalinity of the water sample, recorded in milligrams per liter, at the time of collection.
6. Dissolved Oxygen (mg/l)—The dissolved oxygen content of the water sample, recorded in milligrams per liter, at the time of collection.
7. Volume Sample Collected (ml)—The amount of sample collected, recorded in milliliters.
8. Vacuum Applied—Record the vacuum pressure, recorded in centibars, applied to the soil water sampler to collect a sample.
9. Location Description—Approximate location of soil water sampler with respect to some known geographic location.

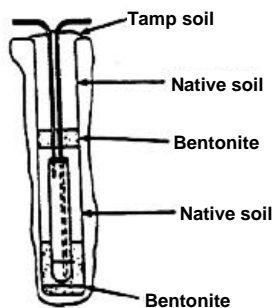
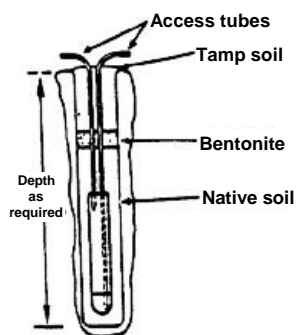
Sample Characteristics:

1. Nonacidified—Number of sample containers, of the indicated size, filled by the specified field-preparation method.
2. Acidified—Number of sample containers, of the indicated size, filled by the specified field-preparation method.
3. Vol Acid (ml)—Volume of acid, recorded in milliliters, added to that sample.
4. Specify Others—Record any other sizes of sample containers that you filled.

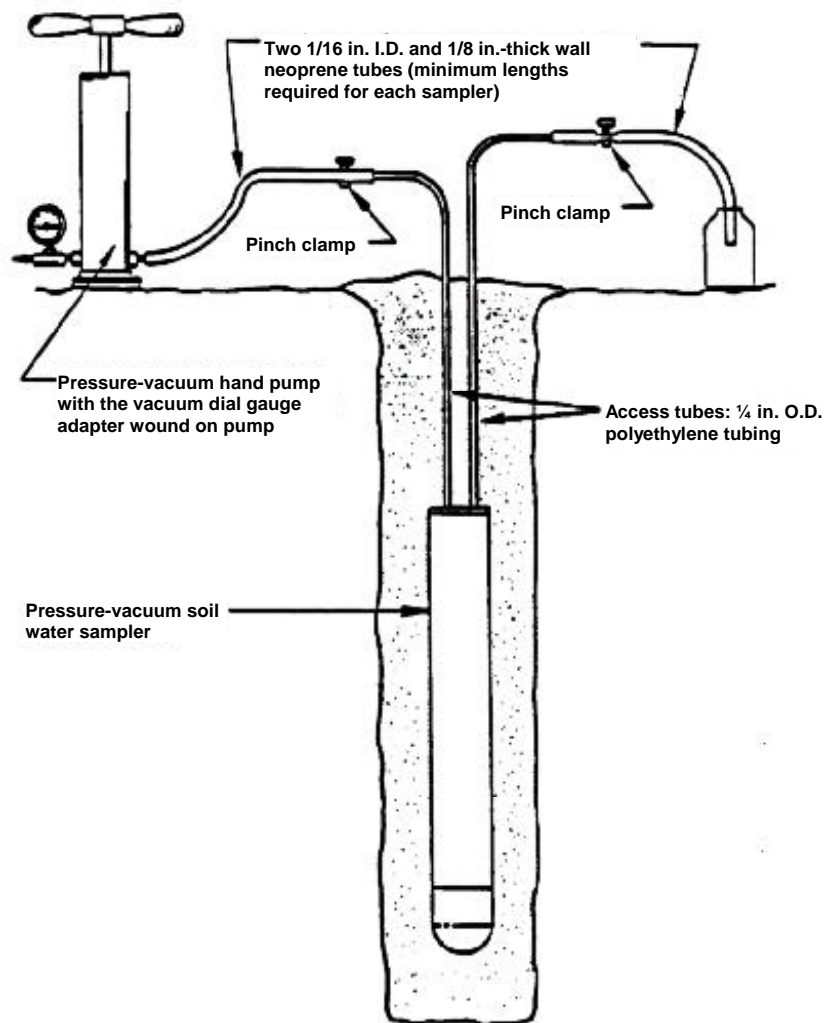
Comments:

Record any information or comments relevant to this process that does not fit specifically in any of the previously described spaces on the form.

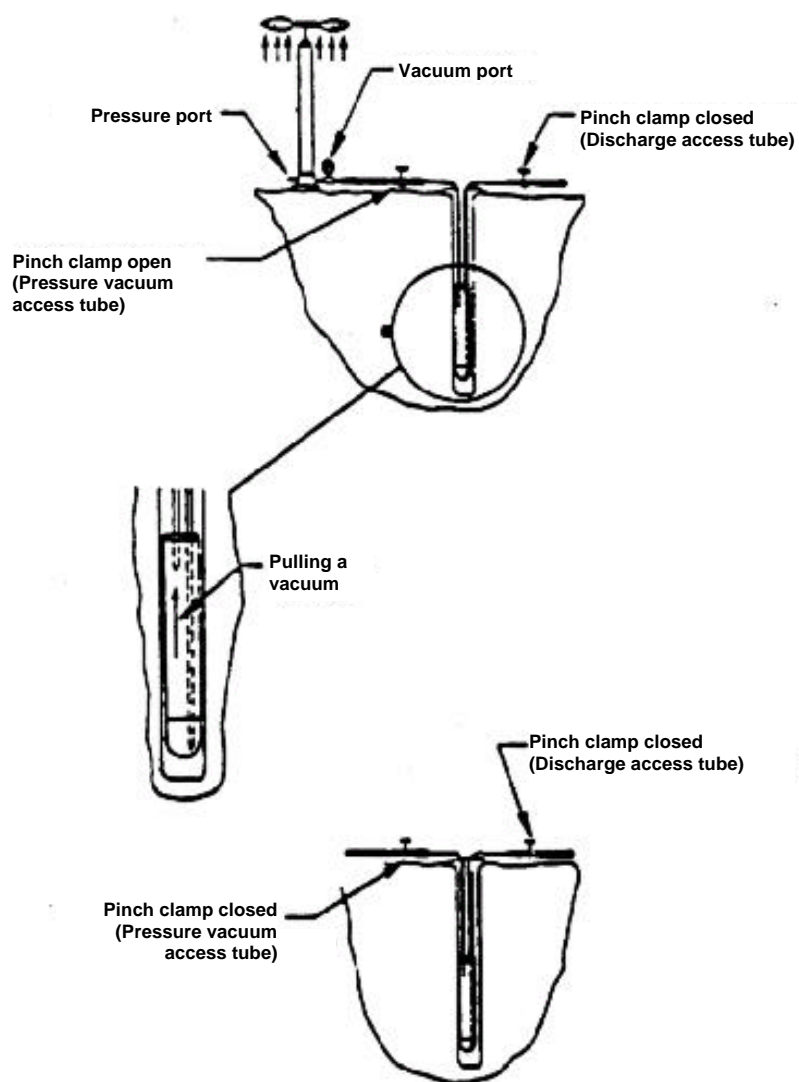
Soil Water Sampler Installation Showing Bentonite Seal



Soil Water Sampler Installation Showing Pressure-Vacuum Assembly



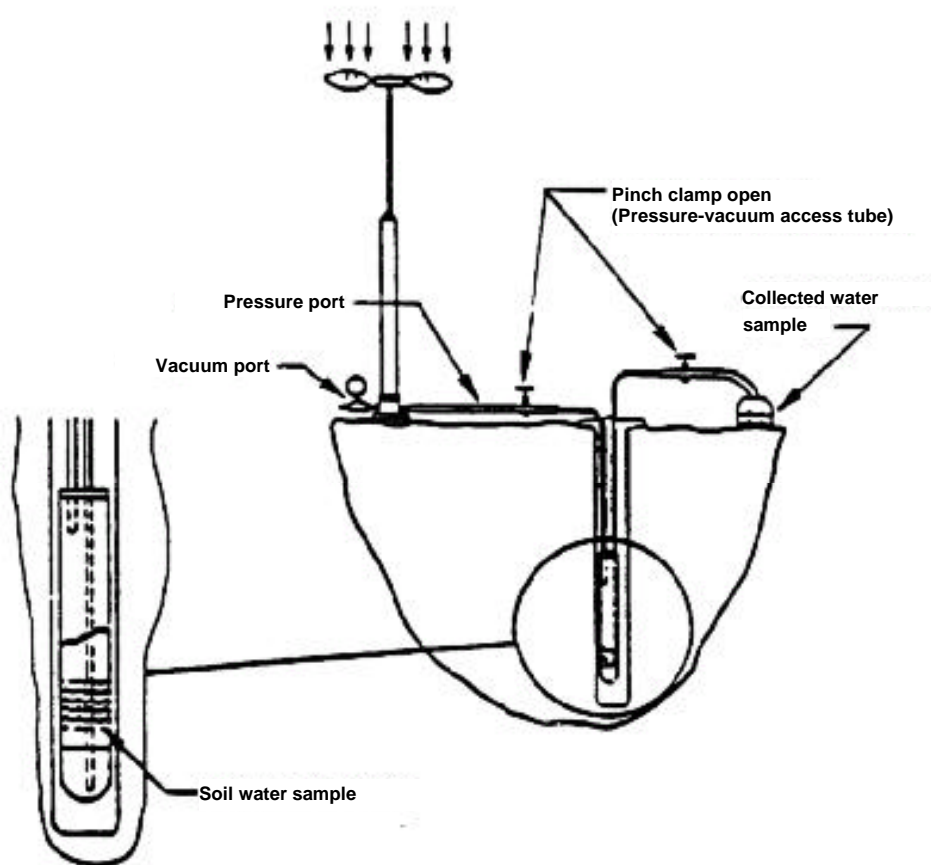
Purging of Slurry Water with Soil Sampler



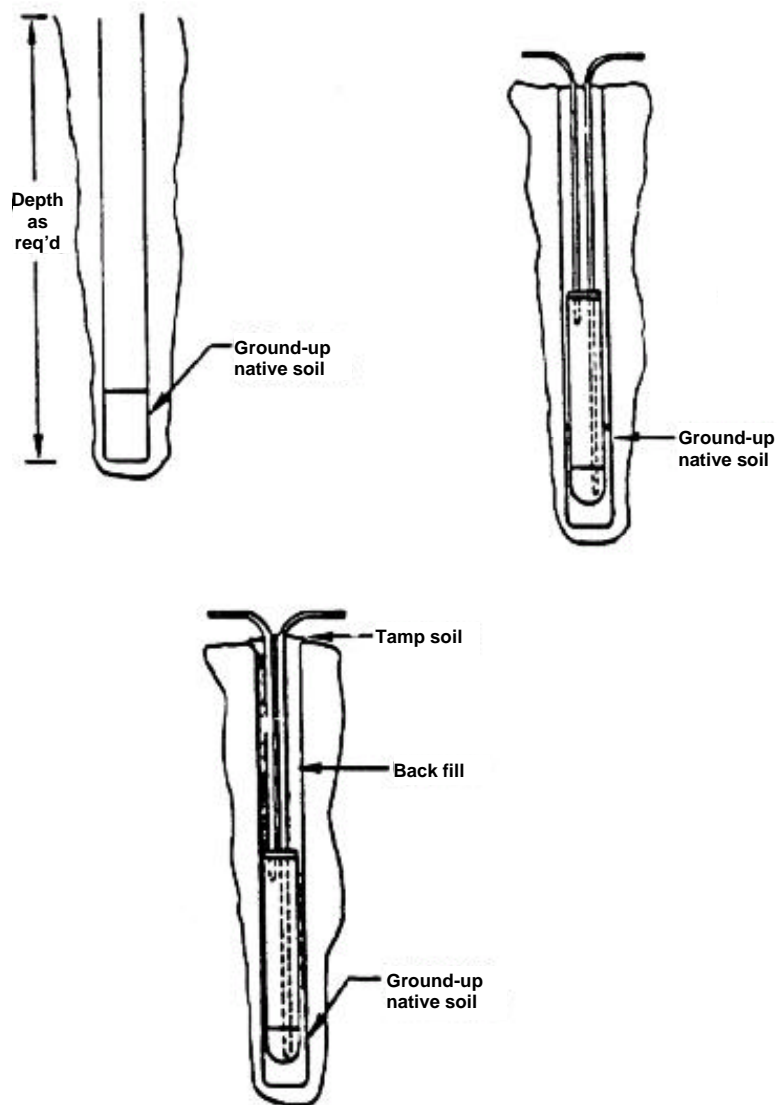
ER-SOP-6.05

Los Alamos
Environmental Restoration Project

Collection of Soil Water Samples



Soil Water Sampler Installation



ER-SOP-6.05

Los Alamos
Environmental Restoration Project